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COMPLEX LEARNING AND CONDITIONING AS A FUNCTION OF ANXIETY[1]

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According to Hull's (3) theoretical formulation relating response strength to drive, all habit tendencies activated in a given situation are multiplied by the value of the total effective drive (D) then operating. In situations in which there is but a single or highly dominant response tendency, as in classical conditioning, an increase in the strength of the effective drive should, on this hypothesis, increase the probability of occurrence of the response and thus lead to better performance. However, in situations in which a number of different competing response tendencies are aroused, the effect upon performance of an increase in drive strength would depend upon the strength of the correct response tendency relative to the other incorrect tendencies. If the habit strength of the correct response should be relatively weak, an increase in drive should further increase the strength of the incorrect tendencies relative to the correct tendency, resulting in impaired performance. Furthermore, the degree of impairment should be a positive function of the number and strength of the competing incorrect response tendencies.[2]

One method of studying the effects of variations in the drive level of human *Ss* has been to select individuals on the basis of their scores on the Taylor Anxiety Scale (10). These scores, it has been assumed, are an index of *Ss'* state of *reactivity* or *excitability*, which in turn reflects their general level of drive (D). On this supposition it has been predicted and confirmed that relatively anxious *Ss*—those obtaining high scores on the anxiety scale—would exhibit a higher level of performance in classical eyelid conditioning than relatively nonanxious *Ss* (9, 10).[3] It has also been predicted that in complex learning tasks, i.e., those involving strong competing responses, the performance of anxious *Ss* would be impaired relative to that of nonanxious *Ss*, the degree of this impairment being positively related to the number and strength of the interfering responses. This pre-

[1] This study was carried out as part of a project on the influence of motivation on performance in learning under Contract N9onr-93802, Project NR 154-107, between the State University of Iowa and the Office of Naval Research. The data on maze learning were collected by Robert S. Dvorin and the conditioning data by Elaine Taylor.

[2] As Taylor and Spence have indicated, "even in instances in which the habit strength of the correct response is stronger than any of the alternative superthreshold responses, the effect of increasing the drive, and hence the number of superthreshold responses, would be to increase the number of errors [due to the operation of oscillation (sOs)]" (11, p. 62).

[3] Hilgard, Jones, and Kaplan (2) did not find a significant relation between amount of anxiety as measured by the Taylor Anxiety Scale and amount of eyelid conditioning to the positive stimulus in a study of differential conditioning. It seems fair to point out, however, that they used only a relatively small number of *Ss* whose anxiety scores were comparable to those used in the studies by Taylor and by Spence and Taylor. They did obtain a highly significant difference in favor of anxious *Ss* in respect to frequency of responses to the negative stimulus (a result that would be predicted on the present hypothesis). The failure to obtain a similar result for responses to the positive stimulus is somewhat puzzling in view of the high correlation ($r = .75$) they report between the frequency of reponses to the positive and negative stimuli.

diction has also been verified (5, 7, 11).

The present study represents a further investigation of the performance of anxious and nonanxious *Ss* on a task involving response competition, namely the learning of a ten-choice stylus maze in which the level of difficulty of the choices had been previously established in an earlier investigation. Since most of these *Ss* also served in an eyelid-conditioning experiment, which is reported separately (8), an analysis is also reported in the present paper concerning the quality of performance of the anxious and nonanxious groups in the two situations.

Procedure

Subjects.—The *Ss* were selected from undergraduate psychology courses on the basis of their scores on a modified form of the Taylor Anxiety Scale. The anxious and nonanxious groups in the maze study each consisted of 40 students whose scores fell respectively within the upper and lower 20% of scores for a standardization population of about 2000 students. Of these, 28 anxious and 26 nonanxious *Ss* also served in the conditioning experiment. All *Ss* were naive with respect to the experimental tasks and were unaware of the reason for their selection.

Apparatus and procedure.—The stylus maze was of a conventional design cut in a piece of ⅛-in. brass sheeting 9¾ in. wide and 12¾ in. long. It consisted of a series of ten T choice points, whose relative levels of difficulty had been established some ten years previously in terms of the total number of errors made at each choice point by a group of 20 unselected *Ss* from an undergraduate course in experimental psychology. The sequence of correct choices and the rank order of difficulty of each, as determined by the earlier investigation were as follows (higher ranks represent greater difficulty):

Choice	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Corr. R	R	L	R	L	L	R	L	R	R	L
Difficulty	3	1	7	2	10	5	9	4	6	8

The maze rested on a metal-covered table behind a cloth screen that prevented *S* from seeing the maze. An ordinary pencil was used as the stylus.

Each *S* was instructed to move forward to the first choice point at the sound of a buzzer and then sideways, right or left. If the choice was correct, *E* said "yes"; if it was wrong, *E* said "no," in which case *S* corrected his response by moving in the opposite direction, past the choice point. When the buzzer again sounded, *S* moved up to the next choice point and made his choice. A demonstration maze differing in design from the experimental maze was placed in front of the screen during the reading of the instructions and each *S* was given a brief practice in responding to the buzzer and in correcting his response following a wrong choice. Following this practice period the demonstration maze was removed.

During the experiment the buzzer was sounded at 5-sec. intervals, so that the time allowed for a choice at each point was relatively constant for all *Ss*. At the end of each trial, *E* moved *S*'s hand back to the starting position for the next trial. The intertrial interval was approximately 10 sec. and each *S* was run to a criterion of two successive errorless trials.

After an interval of one to several days following the maze learning, most of the *Ss* served in an eyelid-conditioning experiment in which 60 conditioning trials and 40 extinction trials were given, according to a procedure described by Spence and Farber (8).

Results and Discussion

Stylus maze performance.—The means, medians, and *SD*'s of the number of errors and the number of trials to the criterion of maze learning for

TABLE 1

Stylus Maze Performance of Anxious and Nonanxious *Ss*

Group	*N*	Errors			Trials to Criterion		
		M	*Mdn*	*SD*	*M*	*Mdn*	*SD*
Anxious	40	19.15	17.0	10.61	8.28	8.0	2.99
Nonanxious	40	13.70	11.5	8.05	6.88	6.0	3.06

the anxious and nonanxious *Ss* are presented in Table 1. These data indicate that the nonanxious *Ss* were superior to the anxious in terms of both number of errors ($t = 2.56$, $p < .02$) and number of trials to the criterion of mastery ($t = 2.03$, $p < .05$). Since the distributions for both measures departed from normality, the differences between the groups were also analyzed by means of a nonparametric test of significance (4), with similar results. In the case of the error scores the x/σ value was 3.07 ($p = .002$), and for the trials measures x/σ was 2.57 ($p = .01$).

These results are highly similar to those obtained in the serial learning situation previously studied by Taylor and Spence (11) and are consonant with the theoretical expectation that nonanxious *Ss* would perform better than anxious *Ss* in a complex learning situation.

A further implication of the present theory was that the advantage of the nonanxious over the anxious group would be positively related to the level of difficulty of the individual choice points, on the assumption that relative difficulty (number of errors) at a choice point reflects the relative strength of competing incorrect response tendencies at that point. Accordingly, the total number of errors made by the two groups was computed for each choice point. These data are presented in Table 2. They indicate that, although the nonanxious *Ss* were superior to the anxious at every choice point but one, the extent of this superiority tended to vary with the difficulty of the choice point as determined by the performance of an unselected group (see Procedure). The rank-order correlation between the level of difficulty of a choice point and the magnitude of the difference between the number of errors by the two groups at that point was found to be .74, which for 9 *df* yields $p < .01$. This result confirmed a similar finding by Taylor and Spence.

Since the difference between the two groups tended to be greater at the more difficult choice points than at the less difficult ones, it follows that an increase in difficulty impaired the performance of the anxious *Ss* to a greater extent than that of the nonanxious *Ss*. Accordingly, it would be expected that the difference between the number of errors made at the difficult choice points and the number of errors at the less difficult choice points would be greater in the case of the anxious group. The mean difference between the number of errors made by the anxious *Ss* at the five easiest choice points—1, 2, 4, 6, 8—and the five hardest choice points—3, 5, 7, 9, 10—was 7.30, $SD = 6.21$. The corresponding mean difference for the nonanxious *Ss* was 5.10, $SD = 3.28$. A t test of this difference yields a value of 1.96, which for 78 *df* is significant at

TABLE 2

NUMBER OF ERRORS AT EACH CHOICE POINT FOR ANXIOUS AND NONANXIOUS *Ss*

Group	N	Choice Point									
		1	2	3	4	5	6	7	8	9	10
Anxious	40	32	39	66	66	144	50	133	50	83	123
Nonanxious	40	22	26	40	40	88	53	100	31	58	90

$< .03$ on a single-tailed hypothesis.[4] Thus, the results of this test also conform to theoretical expectation.

Although the nonanxious *Ss* were relatively better than the anxious *Ss* at the more difficult choice points than at the easier ones, they nevertheless made fewer errors, on the average, even at the easiest choice points. Unfortunately, it is not possible to specify independently of *Ss'* performance whether or not there were competing responses at these easy choice points. Their ease of learning indicates that little or no competition occurred. If this were so, then as Taylor and Spence have suggested in connection with similar findings in their study, such results are not entirely in accord with the theory.

Another possible interpretation of these results in both experiments is that the difference between the performance of the anxious and nonanxious groups is due, not to a difference in their drive level, but rather to a difference in their learning ability. A test of this interpretation might be made by analyzing the performance of anxious and nonanxious *Ss* whose total scores are identical, i.e., of *Ss* who made exactly the same number of errors. On the assumption that there was no difference in the drive level of these paired *Ss*, it follows that they must also have been equated with respect to learning ability, as their performances were the same. Given equal learning ability, the performance of the two groups should not be expected to differ for the easy and difficult choice points.

To satisfy the conditions of the proposed test of the foregoing interpretation, anxious *Ss* were paired with nonanxious *Ss* who made identical total scores. The mean number of errors for 20 pairs thus selected was 13.55, $SD = 4.20$. The means and *SD*'s of the scores for the two matched groups at the five most difficult and at the five least difficult choice points are presented in Table 3. It may be seen from these results that the anxious *Ss* performed better at the easier choice points and more poorly at the more difficult choice points than did the nonanxious *Ss*. The t for matched groups between the two means at the easier points was 1.84, which for 19 df yields $p < .05$, by a single-tailed test. (The test of the difference between the means of the two groups at the more difficult choice points would, of course, yield identical results in the opposite direction.) These results indicate that these particular anxious and nonanxious groups differed with respect to some factor other than learning ability alone. They are consistent, instead, with the view that they differed in drive level, the difference sometimes leading to superior performance by the former group and sometimes to superior performance by the latter group, depending on the difficulty of the choice points.

TABLE 3

ERRORS OF 20 PAIRS OF ANXIOUS AND NONANXIOUS *Ss* AT FIVE MOST DIFFICULT AND FIVE LEAST DIFFICULT CHOICE POINTS

Group	Least Difficult Choices		Most Difficult Choices	
	M	*SD*	*M*	*SD*
Anxious	3.45	1.75	10.10	3.79
Nonanxious	4.40	2.22	9.15	2.97

[4] Although the variances of these two distributions of difference scores were dissimilar, Norton (6) has recently shown that variance differences of this magnitude do not to any appreciable degree affect the results of the t test of significance.

Comparison of stylus maze performance and eyelid conditioning.—In order to compare the performance in maze learning and in conditioning of those Ss who served in both tasks, it was necessary to transform the scores for the two tasks into comparable units. Accordingly, the stylus maze scores (number correct) for the 26 anxious [6] and 26 nonanxious Ss who served in both tasks were placed in a single distribution and translated into normalized values on a linear scale of 100 points with a mean of 50, in accordance with a procedure suggested by Guilford (1, pp. 247–250). The conditioning scores (total number of conditioned responses for 60 conditioning and 40 extinction trials) of these 52 Ss were transformed in the same manner.

TABLE 4

TRANSFORMED SCORES OF 26 ANXIOUS AND 26 NONANXIOUS Ss IN TWO TASKS

Group	Maze Learning		Conditioning	
	M	*SD*	*M*	*SD*
Anxious	43.04	17.64	54.42	16.15
Nonanxious	56.88	17.46	45.38	20.53

The means and *SD*'s of these transformed scores for the anxious and nonanxious Ss in the two tasks are presented in Table 4. It may be seen from these data that the very same anxious Ss who were inferior to the nonanxious Ss in maze performance were superior to that same nonanxious group in conditioning.

TABLE 5

ANALYSIS OF VARIANCE OF TRANSFORMED SCORES OF ANXIOUS AND NONANXIOUS Ss IN MAZE LEARNING AND CONDITIONING

Source	*df*	*ms*	*F*
Between Ss			
Between groups	1	150.24	
Error (B)	50	317.74	
Within Ss			
Between tasks	1	.08	
Groups × Tasks	1	3404.09	9.54**
Error (W)	50	356.75	

** Significant at .01 level of confidence.

An analysis of variance based on these results is presented in Table 5. This analysis indicates that only the interaction between group and task was significant, i.e., the difference between the performance of the anxious and nonanxious Ss depended on the task. No main effects were found, of course. When the simple effects were considered, the anxious Ss were found to be inferior to the nonanxious Ss in maze performance ($p < .01$, $F = 7.84$, $df = 1$ and 50) and superior to the nonanxious group in conditioning ($p < .05$, $F = 3.34$, $df = 1$ and 50). The performance of the anxious Ss was relatively better in conditioning than in maze learning ($p < .03$, $F = 4.72$, $df = 1$ and 50), whereas the performance of the nonanxious Ss, on the other hand, was relatively better in maze learning than in conditioning ($p < .03$, $F = 4.82$, $df = 1$ and 50).[6]

These results are clearly in accord with the supposition that anxious and nonanxious Ss differ in respect to drive

[6] The number of anxious Ss who served in both studies was 28. Of these, 11 were men and 17 were women. Since there is evidence (8) that conditioning scores may be related to sex, it was considered desirable to keep the sex-ratio constant in the anxious and nonanxious groups. The latter group consisted of 11 men and 15 women. Accordingly, the data for two women who had the lowest anxiety scores in the anxious group were omitted from the present analysis. Their inclusion would not have affected the results.

[6] All probability values in the analysis of these simple effects were halved in accordance with a single-tailed hypothesis since the direction of the difference conformed in each instance to theoretical expectation.

level (D) rather than in any general ability to learn. Furthermore, they support the view that no blanket statement can be made concerning the relation of motivation to the quality of performance. Whether an increase in motivation (D) will benefit performance or impede it depends, to an important extent, upon the nature of the task involved.

Summary

The present study was concerned with the performance of anxious and nonanxious *Ss* on a stylus maze. It was predicted that the total performance of the nonanxious group would be superior to that of the anxious group in this relatively complex task, with the extent of their superiority at each choice point being a positive function of its difficulty. In addition, a comparison was made of the scores of a number of these same anxious and nonanxious *Ss* in eyelid conditioning, a task in which the anxious group was expected to show superior performance.

Two groups of 40 *Ss* each, whose scores were respectively within the upper and lower 20% of scores on the Taylor Anxiety Scale learned the maze. Later, 26 *Ss* from each group served in the conditioning experiment.

The maze performance of the anxious *Ss* was significantly poorer than that of the nonanxious *Ss*, with the more difficult points of choice providing the greatest difference between the two groups. In conditioning, however, the anxious *Ss* were superior to the nonanxious.

On the basis of these results it was concluded that the anxious and nonanxious groups in this study differed with respect to drive level (D) rather than general learning ability, and that the effect of variations in drive level upon performance is a function of specific characteristics of the given task.

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References

1. Guilford, J. P. *Psychometric methods.* New York: McGraw-Hill, 1936.
2. Hilgard, E. R., Jones, L. V., & Kaplan, S. J. Conditioned discrimination as related to anxiety. *J. exp. Psychol.*, 1951, **42**, 94–99.
3. Hull, C. L. *Principles of behavior.* New York: D. Appleton-Century, 1943.
4. Mann, H. B., & Whitney, D. R. On a test of whether one of two random variables is stochastically larger than the other. *Ann. math. Statist.*, 1947, **18**, 50–60.
5. Mosteller, F. K. The role of anxiety in serial rote learning. *J. exp. Psychol.*, 1953, **45**, 91–96.
6. Norton, D. W. An empirical investigation of the effects of non-normality and heterogeneity upon the *F*-test of analysis of variance. Unpublished doctor's dissertation, State Univer. of Iowa, 1952.
7. Ramond, C. K. Anxiety and task as determiners of verbal performance. Unpublished master's thesis, State Univer. of Iowa, 1952.
8. Spence, K. W., & Farber, I. E. Conditioning and extinction as a function of anxiety. *J. exp. Psychol.*, 1953, **45**, 116–119.
9. Spence, K. W., & Taylor, J. A. Anxiety and strength of the UCS as determiners of the amount of eyelid conditioning. *J. exp. Psychol.*, 1951, **42**, 183–188.
10. Taylor, J. A. The relationship of anxiety to the conditioned eyelid response. *J. exp. Psychol.*, 1951, **41**, 81–92.
11. Taylor, J. A., & Spence, K. W. The relationship of anxiety level to performance in serial learning. *J. exp. Psychol.*, 1952, **44**, 61–64.